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Alperovich et al.

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(54) **SYSTEM, APPARATUS AND METHOD FOR PAGING OPTIMIZATION USING SUB-LOCATION AREAS**

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(*) Notice: Under 35 U.S.C. 154(b), the term of this patent shall be extended for 0 days.

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(51) **Int. Cl.**[7] **H04Q 7/20**
(52) **U.S. Cl.** **455/433**; 455/456
(58) **Field of Search** 455/432, 433, 455/435, 456, 457, 445, 422, 517, 524

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PCT International Search Report dated Nov. 3, 1999.

Primary Examiner—Reinhard J. Eisenzopf
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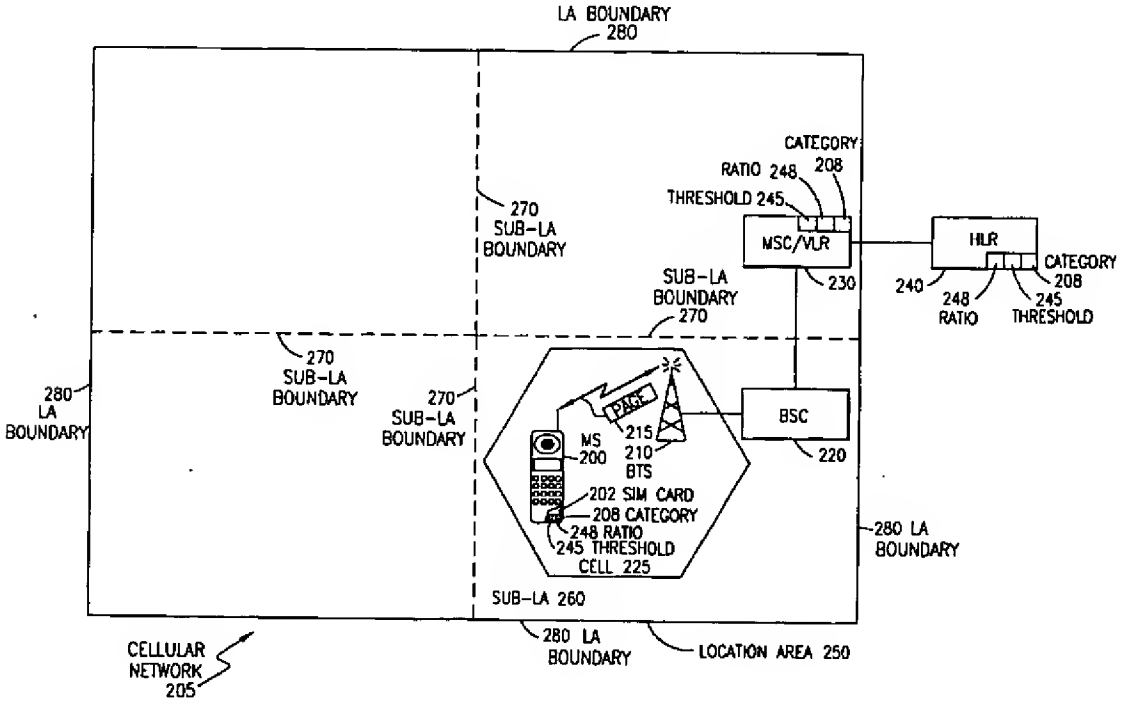
(74) *Attorney, Agent, or Firm*—Jenkens & Gilchrist, P.C.

(57) **ABSTRACT**

A telecommunications system, apparatus and method is disclosed for optimizing the use of paging channels within the network by dividing location areas (LAs) into sub-location areas (sub-LAs) and providing a more efficient and flexible method of paging mobile subscribers. The amount of usage of the paging channels and the number of location updates performed by a mobile subscriber can be monitored by the network to determine either statistical data or a subscriber category, e.g., heavy-user or light-user, which can be stored within the Subscriber Identity Module (SIM) card within the mobile station (MS). The sub-LA information along with the LA information for the cell that the mobile terminal is in is broadcast and monitored by the SIM card within the MS, which can then perform location updates based upon the category or data. The Mobile Switching Center/Visitor Location Register can also use the data or category for paging purposes, e.g., either page within the entire LA or within only the sub-LA, for more focused paging.

43 Claims, 2 Drawing Sheets



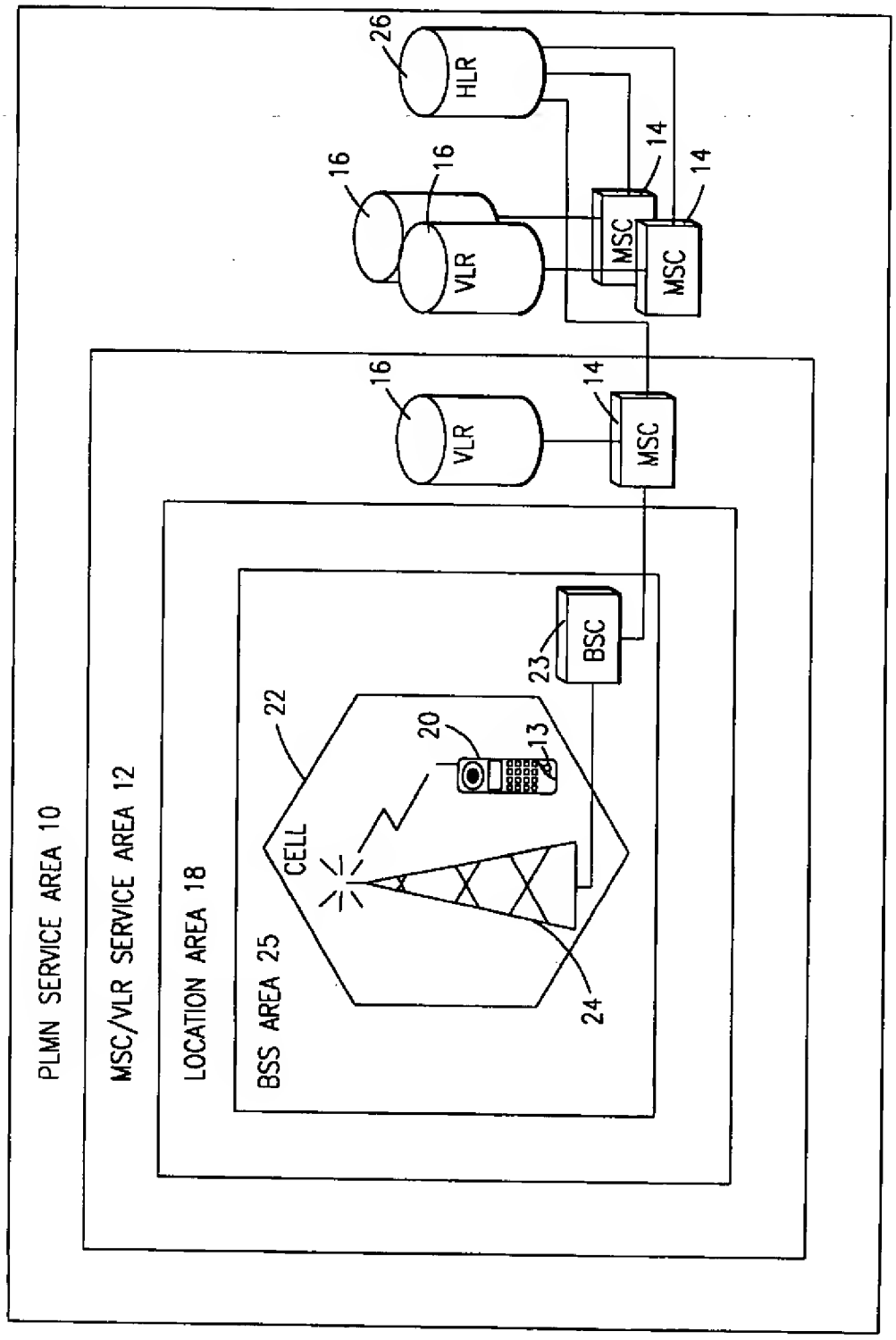

PLMN SERVICE AREA 10
MSC/VLR SERVICE AREA 12
LOCATION AREA 18
BSS AREA 25
CELL
HLR
VLR
VLR
MSC
MSC
MSC
BSC
26
16
16
16
14
14
14
23
22
20
13
24

FIG. 1

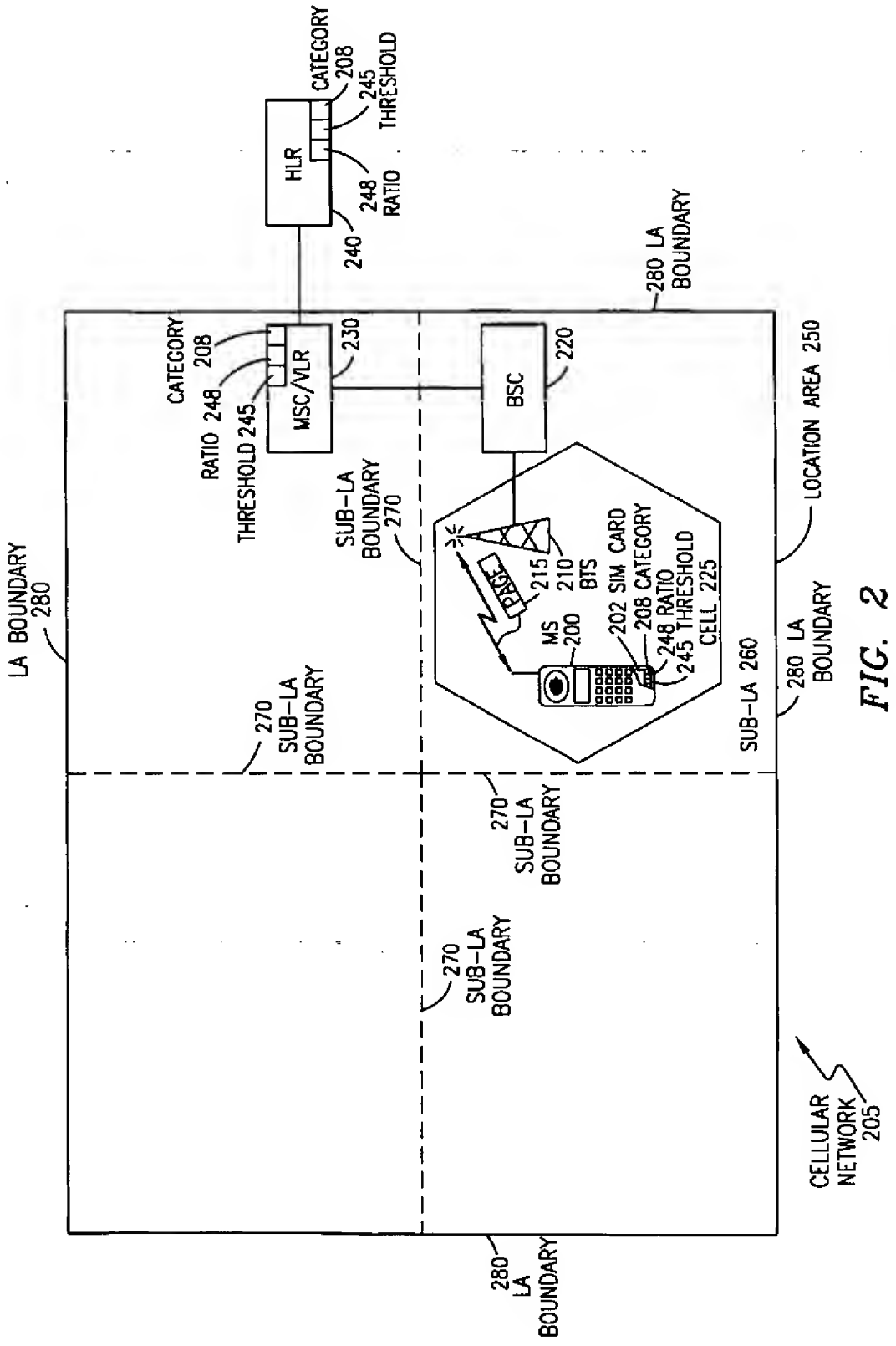

HLR
CATEGORY 208
245 THRESHOLD
248 RATIO
240
280 LA BOUNDARY
CATEGORY 208
RATIO 248
THRESHOLD 245
MSC/VLR
230
BSC
220
SUB-LA BOUNDARY 270
LOCATION AREA 250
LA BOUNDARY 280
270 SUB-LA BOUNDARY
PAGE
215
210 BTS
MS 200
202 SIM CARD
208 CATEGORY
248 RATIO
245 THRESHOLD
CELL 225
SUB-LA 260
280 LA BOUNDARY
270 SUB-LA BOUNDARY
270 SUB-LA BOUNDARY
280 LA BOUNDARY
CELLULAR NETWORK 205

FIG. 2

SYSTEM, APPARATUS AND METHOD FOR PAGING OPTIMIZATION USING SUB-LOCATION AREAS

BACKGROUND OF THE PRESENT INVENTION

1. Field of the Invention

The present invention relates generally to a telecommunications system, apparatus and method for paging mobile terminals within a cellular network, and specifically to optimizing use of paging channels by dividing location areas into sub-location areas and providing a more flexible and efficient method of paging mobile subscribers.

2. Background and Objects of the Present Invention

Cellular telecommunications is one of the fastest growing and most demanding telecommunications applications ever. Today it represents a large and continuously increasing percentage of all new telephone subscriptions around the world. A standardization group, European Telecommunications Standards Institute (ETSI), was established in 1982 to formulate the specifications for the Global System for Mobile Communication (GSM) digital mobile cellular radio system.

With reference now to FIG. **1** of the drawings, there is illustrated a GSM Public Land Mobile Network (PLMN), such as cellular network **10**, which in turn is composed of a plurality of areas **12**, each with a Mobile Services Center (MSC) **14** and an integrated Visitor Location Register (VLR) **16** therein. The MSC/VLR areas **12**, in turn, include a plurality of Location Areas (LA) **18**, which are defined as that part of a given MSC/VLR area **12** in which a mobile station (MS) **20** may move freely without having to send update location information to the MSC/VLR area **12** that controls the LA **18**. Each Location Area **12** is divided into a number of cells **22**.

Mobile Station (MS) **20** is the physical equipment, e.g., a car phone or other portable phone, used by mobile subscribers to communicate with the cellular network **10**, each other, and users outside the subscribed network, both wireline and wireless. The MS **20** may also include a Subscriber Identity Module (SIM) card **13**, or other memory, which provides storage of subscriber related information, such as a subscriber authentication key, temporary network data, and service related data (e.g. language preference).

The MSC **14** is in communication with at least one Base Station Controller (BSC) **23**, which, in turn, is in contact with at least one Base Transceiver Station (BTS) **24**. The BTS **24** is the physical equipment, illustrated for simplicity as a radio tower, that provides radio coverage to the geographical part of the cell **22** for which it is responsible. It should be understood that the BSC **23** may be connected to several base transceiver stations **24**, and may be implemented as a stand-alone node or integrated with the MSC **14**. In either event, the BSC **23** and BTS **24** components, as a whole, are generally referred to as a Base Station System (BSS) **25**.

With further reference to FIG. **1**, the PLNN Service Area or cellular network **10** includes a Home Location Register (HLR) **26**, which is a database maintaining all subscriber information, e.g., user profiles, current location information, International Mobile Subscriber Identity (IMSI) numbers, and other administrative information. The HLR **26** may be co-located with a given MSC **14**, integrated with the MSC **14**, or alternatively can service multiple MSCs **14**, the latter of which is illustrated in FIG. **1**.

The VLR **16** is a database containing information about all of the Mobile Stations **20** currently located within the MSC/VLR area **12**. If an MS **20** roams into a new MSC/VLR area **12**, the MSC **14** will request data about that Mobile Station **20** from the HLR database **26** (simultaneously informing the HLR **26** about the current location of the MS **20**) and store the data in the VLR **16** connected to that MSC **14**. Accordingly, if the user of the MS **20** then wants to make a call, the local VLR **16** will have the requisite identification information without having to reinterrogate the HLR **26**. In the aforedescribed manner, the VLR and HLR databases **16** and **26**, respectively, contain various subscriber information associated with a given MS **20**.

The radio interface is the general name of the connection between the MS **20** and the BTS **24**, which utilizes timeslots (TS) within each allocated frequency to transmit speech, data and control signaling, with each TS being referred to as a physical channel. Different types of information, e.g., speech, user data and control signaling, must be transmitted on these physical channels through the use of logical channels, which are mapped onto the physical channels. The logical channels can be divided into two groups: control channels and traffic channels. Speech is sent on the traffic channels, while user data and control signaling are transmitted on control channels.

One type of control channel is a paging channel (PCH) to which the MS **20** listens to see if the network **10** wants to get in contact with the MS **20**. For example, the network **10** may wish to get in contact with the MS **20** because the network **10** is receiving an incoming call or a Short Message Service (SMS) message for the MS **20**. The information on a PCH is a paging message, which includes the MS's identity number. The paging message is transmitted to the MS **20** on the downlink (from the BTS **24** to the MS **20**), as a broadcast message.

The paging channels are a valuable network resource, and thus, optimization of their use will lead to better network frequency utilization and traffic throughput. With the increase in traffic, such as point-to-point SMS messages, the paging capacity is likely to become a bottleneck in the system.

When a subscriber moves from one LA **18** to another, a procedure called Location Update is performed to inform the network **10** where to page the MS **20** in case of an incoming call or message. In general, the smaller the LA **18**, the more Location Updates are generated by MS's **20** moving between LA's **18**. However, if the LA **18** is large, which corresponds to a large number of cells **22**, when a mobile terminating call comes into the network **10**, the called subscriber (MS **20**) is paged within the entire LA **18**, which includes every cell **22** in the LA **18**. Therefore, each BTS **24** within each cell **22** sends a paging message on a separate PCH.

Thus, the larger the LA **18**, the more network resources (paging channels) are used to page a MS **20** within the LA **18**. In sum, there is a trade-off between paging efficiency (most efficient when the LA **18** is small) and the Location Update load (most efficient when the LA **18** is large). However, the size of the LA **18** is typically configured for an average subscriber, while in reality, there are some subscribers, such as business subscribers, who use the MS **20** heavily. For these heavy-use subscribers, a smaller LA **18** is preferred, because these subscribers are paged frequently. In addition, there are also some subscribers who only use the MS **20** for emergencies. For these light-use subscribers, a

large LA 18 is preferred, because the paging activity is minimal. Existing technology has not provided a way to maximize network resources (paging channels) based upon the subscriber usage.

It is, therefore, an object of the present invention to optimize the use of paging channels based upon the usage characteristics for subscribers within the network.

SUMMARY OF THE INVENTION

The present invention is directed to a telecommunications system, apparatus and method for optimizing the use of paging channels within the network by dividing location areas (LAs) into sub-location areas (sub-LAs) and providing a more flexible and efficient method of paging mobile subscribers. The amount of usage of the paging channels and the number of location updates performed by a mobile subscriber can be monitored by the network to determine either a ratio of the number of pages to the number of location updates, or a subscriber category associated with the mobile subscriber. The ratio or subscriber category, e.g., heavy-user or light-user and high-mobility or low-mobility, can be stored within the Subscriber Identity Module (SIM) card within the mobile terminal. Alternatively, the SIM card itself can monitor the paging and location update activity over time and make a determination as to the ratio or subscriber category. When the LA is divided into sub-LAs, the sub-LA information is broadcast over the broadcast channel together with the LA information. The SIM card within the MS can then monitor the broadcast channel and perform location updates based upon the subscriber category or ratio. For example, if the subscriber category is set to heavy/business-use or the ratio is above a threshold percentage for sub-LA location updating, e.g., the number of pages attempted by the subscriber is greater than the number of location updates attempted by the subscriber by a certain percentage, the mobile terminal performs location updates when the boundary between two sub-LA's is crossed. However, for light-use subscribers or if the ratio is below the threshold for sub-LA location updating, location updates are only performed when a boundary between two LAs is crossed. When a location update is performed, the subscriber category or ratio for that mobile terminal is passed onto the MSC/VLR for paging purposes, e.g., either page within the entire LA or within only the sub-LA. As a result, more focused paging is performed for the subscribers who are paged more frequently. It should be noted that the paging (either LA or sub-LA) can also be tailored by location, time and mobility of the subscriber.

BRIEF DESCRIPTION OF THE DRAWINGS

The disclosed inventions will be described with reference to the accompanying drawings, which show important sample embodiments of the invention and which are incorporated in the specification hereof by reference, wherein:

FIG. 1 is a block diagram of a conventional terrestrially-based wireless telecommunications system; and

FIG. 2 is a block diagram illustrating the division of Location Areas into sub-Location Areas in order to maximize efficient usage of paging channels.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EXEMPLARY EMBODIMENTS

The numerous innovative teachings of the present application will be described with particular reference to the presently preferred exemplary embodiments. However, it should be understood that this class of embodiments provides only a few examples of the many advantageous uses of the innovative teachings herein. In general, statements made in the specification of the present application do not necessarily delimit any of the various claimed inventions. Moreover, some statements may apply to some inventive features but not to others.

With reference now to FIG. 2 of the drawings, optimization of the use of paging channels **215** within a cellular network **205** can be achieved by dividing location areas (LA) **250** into sub-location areas (sub-LA) **260** and providing a more flexible and efficient method of paging Mobile Stations (MS) **200** within the cellular network **205** related to the amount of usage of the paging channels **215** by the MS's **200**. In one embodiment, the cellular network, e.g., a Home Location Register (HLR) **240**, can maintain statistical data for each MS **200**, which can include, for example, the number of pages **215** to a specific MS **200** over a predefined period of time, the number of pages **215** for that specific MS **200** per LA **250**, the mobility of the subscriber, e.g., the number of location updates performed by that MS **200**, and the peak time(s) of paging activity for that subscriber.

From this statistical data, the network **205** can determine, for example, a ratio **248** for the MS **200** of the number of paging attempts by the network **205** to the number of location update attempts by the MS **200**. The higher the ratio **248**, the more focused the paging activity should be. Thus, the ratio **248** can be compared with threshold ratios **245** to determine whether the MS **200** should be paged within the entire LA **250** or within the sub-LA **260** and whether the MS **200** should perform location updates between LA's **250** or between sub-LA's **260**.

This ratio **248** and threshold information **245** can be sent to the MS **200** for storage in, for example, a Subscriber Identity Module (SIM) card **202**, or other memory, therein in order for the MS **200** to determine when to perform location updates. In addition, when the MS **200** performs a location update, the MS **200** and the HLR **240** can send this ratio **248** and threshold information **245** to a Mobile Switching Center/Visitor Location Register (MSC/VLR) **230** serving the LA **250** that the MS **200** is currently located in to enable the MSC/VLR **230** to determine whether to page the MS **200** within the entire LA **250** or only within the sub-LA **260**. If the ratio **248** and threshold information **245** sent by the MS **200** differs from that sent by the HLR **240**, the MSC/VLR **230** can then send the new ratio **248** and threshold information **245**, corresponding to the information **248** and **245** sent by the HLR **240**, to the MS **200** for storage in the SIM card **202**. Alternatively, the MSC/VLR **230** can maintain its own threshold information **245** for comparison with the ratio information sent by the MS **200** and HLR **240**.

In an alternative embodiment, the HLR **240** can use the statistical data to determine a subscriber category **208**, e.g., heavy-user or light-user, which can then be sent to the MS **20** and stored within the SIM card **202** within the MS **200**. It should be understood that other subscriber categories can be used instead of the heavy-user and light-user categories discussed herein. For example, the subscriber category can be broken down into two categories **208**, one for the paging activity and one for the location update activity, e.g., either heavy-user or light-user, and either high-mobility or light-mobility. The MS **200** can use the high-mobility or light-mobility categories **208** for location updating, while the MSC/VLR **230** can use the heavy-user or light-user categories **208** for paging purposes.

In a further alternative embodiment, the subscriber category **208** (heavy-user or light-user) can be determined at

the time of subscription, which can he based upon the subscription plan chosen. As an example, if a subscriber chooses a plan with 500 or more minutes a month, a heavy-user subscriber category 208 can be assigned to that MS 200 and stored in the SIM card 202. This subscriber category 208 can also be stored in the subscriber's Home Location Register (HLR) 240, which can then transfer the subscriber category 208 to a Mobile Switching Center/Visitor Location Register (MSC/VLR) 230 serving the LA 250 that the MS 200 is currently located in.

In another alternative embodiment, the SIM card 202 itself can monitor the paging and location update activity of the MS 200 over time and make a determination as to the ratio 248 or subscriber category 208. For example, if the MS 200 receives at least a threshold amount of paging messages 215 as compared to the number of location updates within a predefined period of time, the SIM card 202 can assign a heavy-user subscriber category 208 to the MS 200. By allowing the SIM card 202 to monitor the paging and location update activity, the subscriber category 208 can change dynamically depending upon the paging channel 215 usage by that MS 200 during predefined periods of time.

In another alternative embodiment, the utilization of the paging channels 215 in general can be monitored by the cellular network 205, e.g., Base Station Controllers (BSC) 220 and/or Base Transceiver Stations (BTS) 210 within the LA 250, and this paging channel utilization information can then be sent to the serving MSC/VLR 230, which can then modify the subscriber categories 208 for subscribers in the LA 250 based upon the high utilization of the paging resources 215 in general, instead of the individual paging utilization.

When the ratio 248 and threshold information 245 or subscriber category 208 for the MS 200 is first determined or changes, this information 248 and 245 or 208 can then be sent to the MS 200, using, for example, an Unstructured Supplementary Service Data (USSD) message or a Short Message Service (SMS) message, to be stored in the SIM card 202 or other memory of the MS 200. In addition, if the ratio 248, threshold information 245 or subscriber category 208 for the MS 200 changes based upon the time of day, the SIM card 202 can store each ratio 248, threshold information 245 or subscriber category 208 along with the associated time of day and change the current ratio 248, threshold information 245 or subscriber category 208 itself based upon the time stamp information sent over the broadcast channel by the serving BTS 210.

When each LA 250 is divided into sub-LA's 260, each BTS 210 within the cellular network 205 can broadcast the sub-LA 260 information along with the LA 250 information associated with a cell 225 that the BTS 210 is located in. The SIM card 202 within the MS 200 can then monitor the broadcast channel and perform location updates based upon the ratio 248 or subscriber category 208 stored in the MS 200. For example, if the ratio 248 is below the threshold 245 for performing sub-LA 260 location updates, e.g., the number of pages is low as compared with the number of location updates, or the subscriber category 208 is high-mobility or light-user, location updates can be performed by the MS 200 when the boundary 270 between two sub-LAs 260 is crossed. Alternatively, for high ratios 248 (more pages than location updates) or low-mobility of heavy-user subscriber categories 208, location updates need to be performed only when the boundary 280 between two LAs 250 is crossed.

As discussed hereinhefore, the MSC/VLR 230 also stores the ratio 248 and threshold information 245 or subscriber category information 208 for the MS 200, which can be sent by the MS 200 in the location update, sent by the HLR 240 along with additional subscriber information after the MS 200 performs the location update if the subscriber category 208 is new or different than the subscriber category 208 sent by the MS 200 in the location update, or determined by the MSC/VLR 230 based upon the overall paging utilization. If the ratio 248 or subscriber category 208 sent by the HLR 240 is new or different from the ratio 248 or subscriber category 208 sent by the MS 200 in the location update, the MSC/VLR 230 can then send this new ratio 248 or subscriber category 208 to the MS 200 for use by the MS 200 in future location updates.

The MSC/VLR 230 uses this ratio 248 or subscriber category 208 to determine whether to page 215 the MS 200 within the entire LA 250 or within only one sub-LA 260. For example, if the ratio 248 is high or the subscriber category 208 is heavy-user, the MSC/VLR 230 can page 215 the MS 200 in the sub-LA 260, thus reducing the amount of network resources (paging channels 215) utilized by the network 205 to get in contact with the MS 200. However, if the ratio 248 is low or the subscriber category 208 is light-user, the MSC/VLR 230 can page 215 the MS 200 within the entire LA 250.

As a result, more focused paging 215 is performed for the subscribers who are paged more frequently. It should be noted that the ratio 248 or subscriber category 208 can also be tailored by location, time and mobility of the subscriber. In addition, sub-LAs 260 can in turn be divided into further sub-LA's (not shown) along with associated thresholds 245 or subscriber categories 208.

As will be recognized by those skilled in the art, the innovative concepts described in the present application can be modified and varied over a wide range of applications. Accordingly, the scope of patented subject matter should not be limited to any of the specific exemplary teachings discussed.

For example, it should be understood that the paging channel efficiency systems and methods disclosed herein can be utilized by any cellular network, including, but not limited to the Global System for Mobile Communications (GSM) network, the Personal Communications Systems (PCS) network, the AMPS network and the D-AMPS network.

What is claimed is:

1. A telecommunications system for optimizing the use of paging channels within a cellular network, said telecommunications system comprising:

at least one location area within said cellular network, said location area being divided into at least two sub-location areas;

a mobile terminal in wireless communication with a mobile switching center within said cellular network, said mobile terminal being located within a given one of said sub-location area; and

a memory having threshold information and paging and updating information associated with said mobile terminal stored therein, said paging and updating information comprising a ratio of the number of pages attempted by said mobile switching center to said mobile terminal to the number of location updates attempted by said mobile terminal to said mobile switching center;

wherein said mobile switching center pages said mobile terminal on said paging channels within said given sub-location area and not on said paging channels

within at least one other of said at least two sub-location areas when the value of said ratio is above said threshold information;

wherein said mobile switching center pages said mobile terminal on said paging channels within said location area when the value of said ratio is below said threshold information.

2. The telecommunications system of claim 1, wherein said paging and updating information is associated with the amount of usage of said paging channels by said mobile terminal.

3. The telecommunications system of claim 1, wherein said memory is within said mobile terminal.

4. The telecommunications system of claim 3, wherein said memory is a Subscriber Identity Module card.

5. The telecommunications system of claim 3, wherein said paging and updating information is determined by said memory within said mobile terminal.

6. The telecommunications system of claim 1, wherein said paging and updating information is associated with a predefined time period, said paging and updating information being updated at the end of said predefined time period.

7. The telecommunications system of claim 1, further comprising at least one base station in wireless communication with said mobile terminal and connected to said mobile switching center, said base station being located within said given sub-location area, said paging channels being associated with said base station, said base station broadcasting information associated with said location area and said given sub-location area.

8. The telecommunications system of claim 1, wherein said mobile terminal performs a location update to said mobile switching center when said mobile terminal enters said location area but not when said mobile terminal enters one of said at least two sub-location areas when the value of said ratio is below said threshold information.

9. The telecommunications system of claim 1, further comprising a home location register connected to said mobile switching center, said memory being within said home location register.

10. The telecommunications system of claim 9, wherein said home location register sends, via said mobile switching center, said paging and updating information to said mobile terminal to be stored in a memory therein.

11. The telecommunications system of claim 9, wherein said home location register sends paging and updating information to said mobile switching center, said mobile switching center using said paging and updating information to determine whether to page said mobile terminal within said location area or within said given sub-location area.

12. The telecommunications system of claim 1, wherein said memory is within said mobile terminal, said paging and updating information being determined and sent to said mobile terminal by said mobile switching center.

13. The telecommunications system of claim 1, wherein each of said sub-location areas are further divided into at least two additional sub-location areas.

14. The telecommunications system of claim 1, wherein said memory stores a location update threshold and wherein said mobile terminal performs a location update to said mobile switching center when said mobile terminal enters said given sub-location area but not when said mobile terminal enters said location area when the value of said ratio is below said threshold information and the number of location updates attempted by said mobile terminal is above said location update threshold.

15. The telecommunications system of claim 1, wherein said paging and updating information is associated with at least one subscriber category, said paging and updating information resulting in sub-location area paging when said subscriber category is set to heavy-user, said paging and updating information resulting in location area paging when said subscriber category is set to light-user.

16. The telecommunications system of claim 1, wherein said mobile terminal performs a location update to said mobile switching center when said mobile terminal enters said given sub-location area but not when said mobile terminal enters said location area when the value of said ratio is above said threshold information.

17. A method for optimizing the use of paging channels within a cellular network, said method comprising the step of:

dividing at least one location area within said cellular network into at least two sub-location areas;

determining paging and updating information associated with a mobile terminal in wireless communication with a mobile switching center within said cellular network, said mobile terminal being located within a given one of said sub-location areas, said paging and updating information comprising a ratio of the number of Pages attempted by said mobile switching center to said mobile terminal to the number of location updates attempted by said mobile terminal to said mobile switching center;

paging, by said mobile switching center, said mobile terminal on said paging channels within said given sub-location area and not paging said mobile terminal on said paging channels within at least one other of said at least two sub-location areas when the value of said ratio is above threshold information; and

paging, by said mobile switching center, said mobile terminal on said paging channels within said location area when the value of said ratio is below said threshold information.

18. The method of claim 17, wherein said paging and updating information is associated with the amount of usage of said paging channels by said mobile terminal.

19. The method of claim 17, wherein said paging and updating information and said threshold information are stored in a memory within said mobile terminal.

20. The method of claim 19, wherein said memory is a Subscriber Identity Module card.

21. The method of claim 19, wherein said step of determining is performed by said memory within said mobile terminal.

22. The method of claim 17, wherein said step of determining is performed with a predefined time period.

23. The method of claim 17, further comprising, after said step of determining, the step of:

broadcasting, by at least one base station in wireless communication with said mobile terminal and connected to said mobile switching center, information associated with said location area and said sub-location area, said base station being located within said given sub-location area, said paging channels being associated with said base station.

24. The method of claim 17, further comprising the step of:

performing, by said mobile terminal, a location update to said mobile switching center when said mobile terminal enters said location area but not when said mobile terminal enters one of said at least two sub-location areas when the value of said ratio is below said threshold.

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,185,421 B1
DATED : February 6, 2001
INVENTOR(S) : Vladimir Alperovich et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 1,
Line 59, replace "PLNN" with -- PLMN --.

Column 9,
Line 60, replace "Pares" with -- pages --.

Signed and Sealed this

Twelfth Day of March, 2002

Attest:

Attesting Officer

JAMES E. ROGAN
Director of the United States Patent and Trademark Office

US006683538B1

(12) **United States Patent**
Wilkes, Jr.

(10) **Patent No.: US 6,683,538 B1**
(45) **Date of Patent: Jan. 27, 2004**

(54) **POSITION DEPENDENT MESSAGING SYSTEM**

(76) Inventor: **Robert D Wilkes, Jr.**, 123 Dolphin Ave., Galveston, TX (US) 77550

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/384,316**

(22) Filed: **Aug. 27, 1999**

Related U.S. Application Data

(60) Provisional application No. 60/098,389, filed on Aug. 29, 1998.

(51) **Int. Cl.**[7] **G08G 1/16**

(52) **U.S. Cl.** **340/903**; 340/901; 340/902; 340/905; 340/539.1; 340/539.13; 340/988; 340/989; 340/991

(58) **Field of Search** 340/901, 902, 340/903, 904, 905, 539.1, 991, 988, 989, 992, 993, 995.25, 539.13

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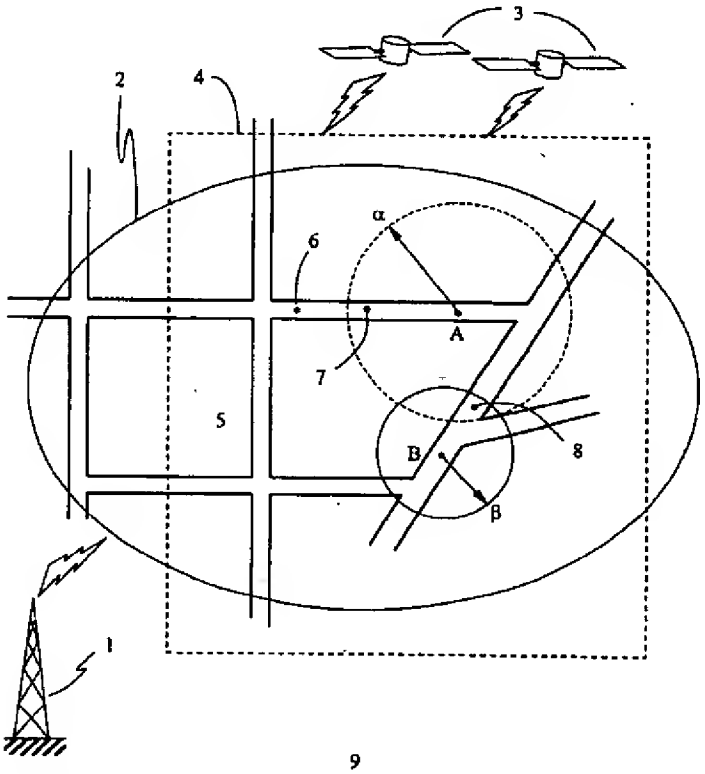
Primary Examiner—Daryl Pope

(57) **ABSTRACT**

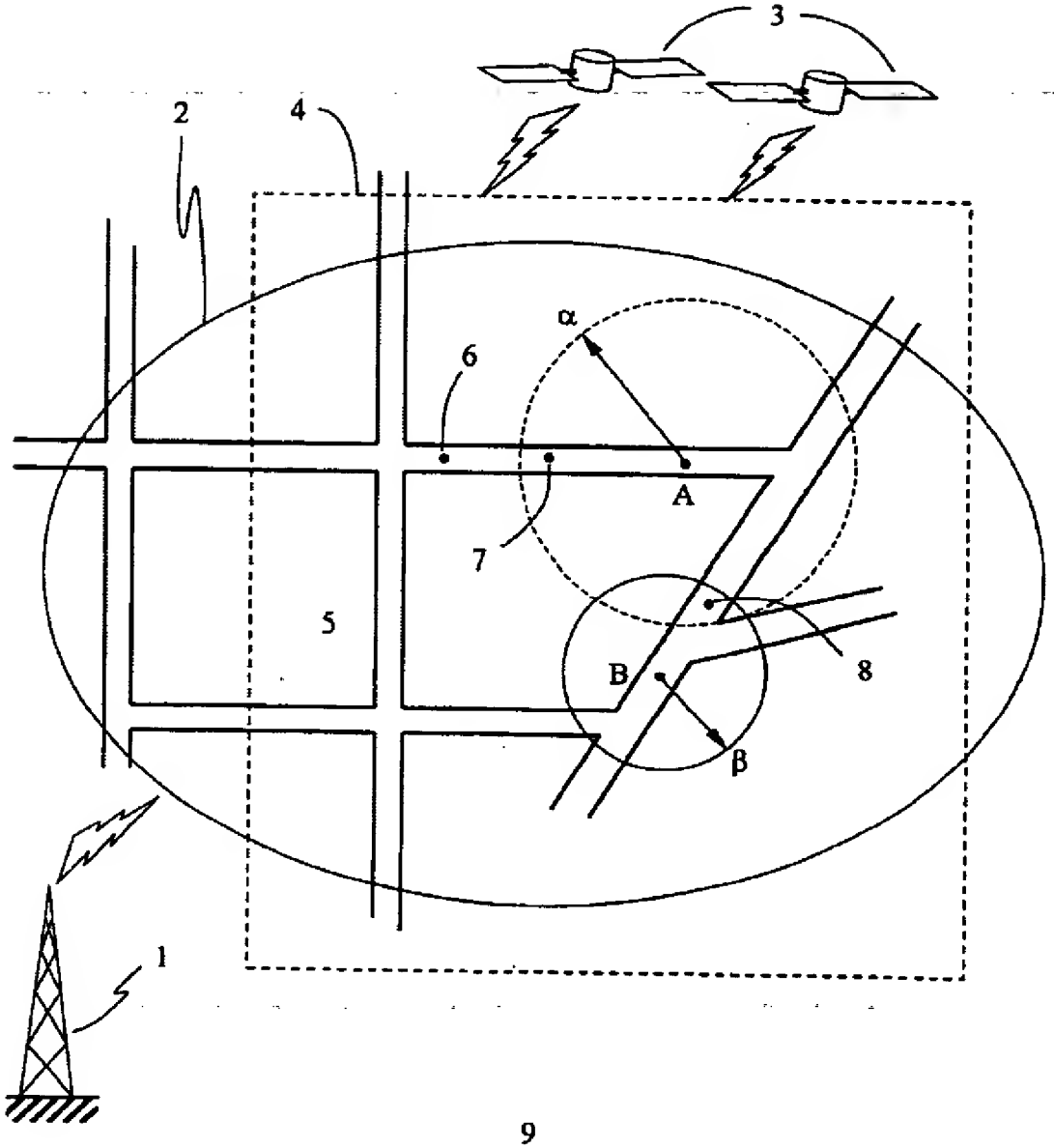
A messaging system is disclosed, delivery of messages being dependent upon the location of the recipient, the number of recipients being unlimited. The message transmitter may be fixed or mobile. The recipient may be either fixed or mobile, but must have knowledge of its own position. The transmitter broadcasts in radio frequencies (or other convenient medium) three pieces of information per message: a location, a trigger distance, and the message. The recipient, knowing its own position, calculates the actual distance to each location being broadcast. If the actual distance is less than the trigger distance, then the message is displayed to the recipient. In this manner, only messages that are relevant to the recipients' position are displayed, and messages relevant to other positions are ignored.

12 Claims, 3 Drawing Sheets



9

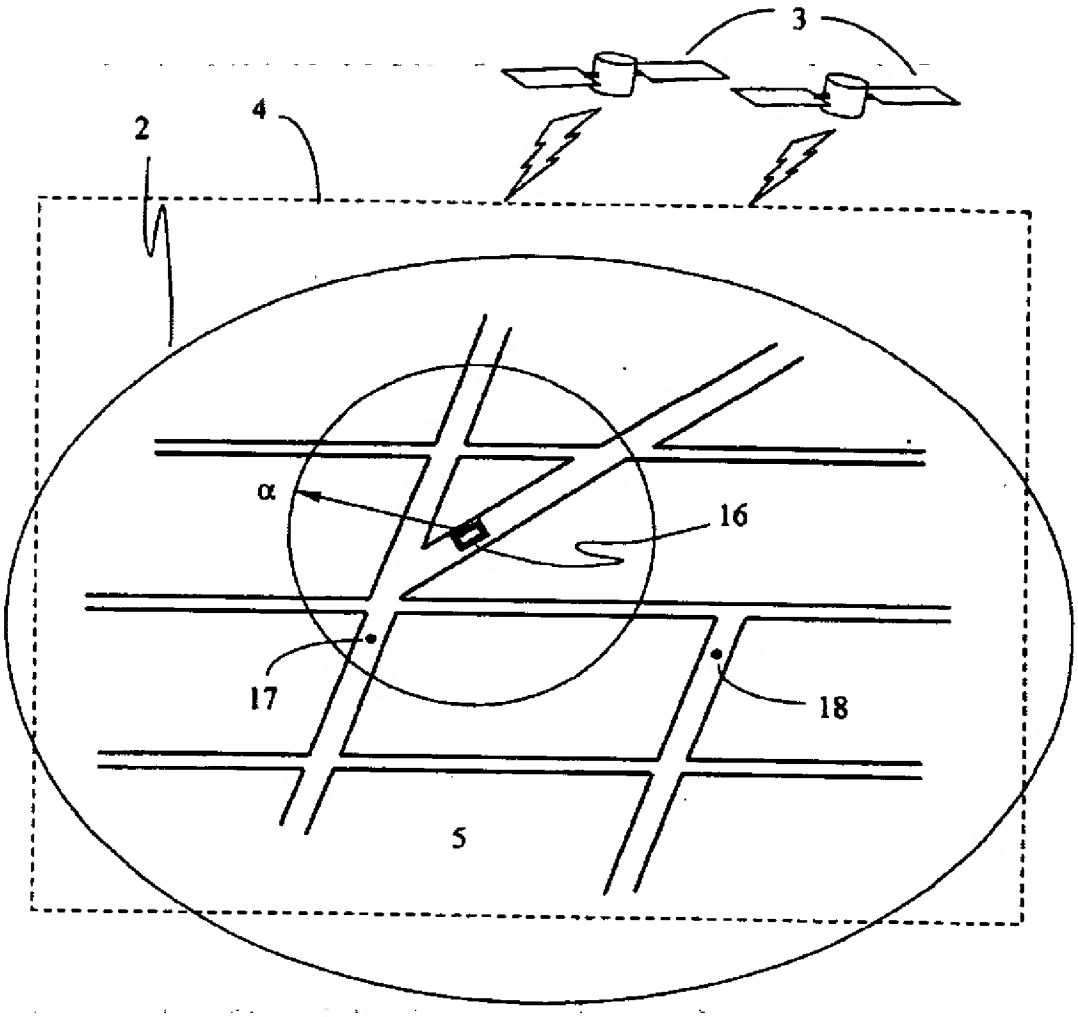
...	LOCATION A	TRIGGER α	MESSAGE A	LOCATION B	TRIGGER β	MESSAGE B	...



9

...	LOCATION A	TRIGGER α	MESSAGE A	LOCATION B	TRIGGER β	MESSAGE B	...

FIG. 1


3
4
2
α
16
17
18
5

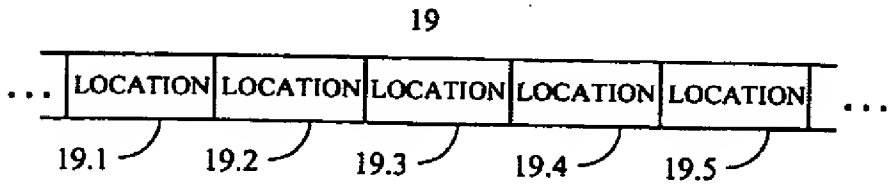

19
...
LOCATION
LOCATION
LOCATION
LOCATION
LOCATION
...
19.1
19.2
19.3
19.4
19.5

FIG. 2

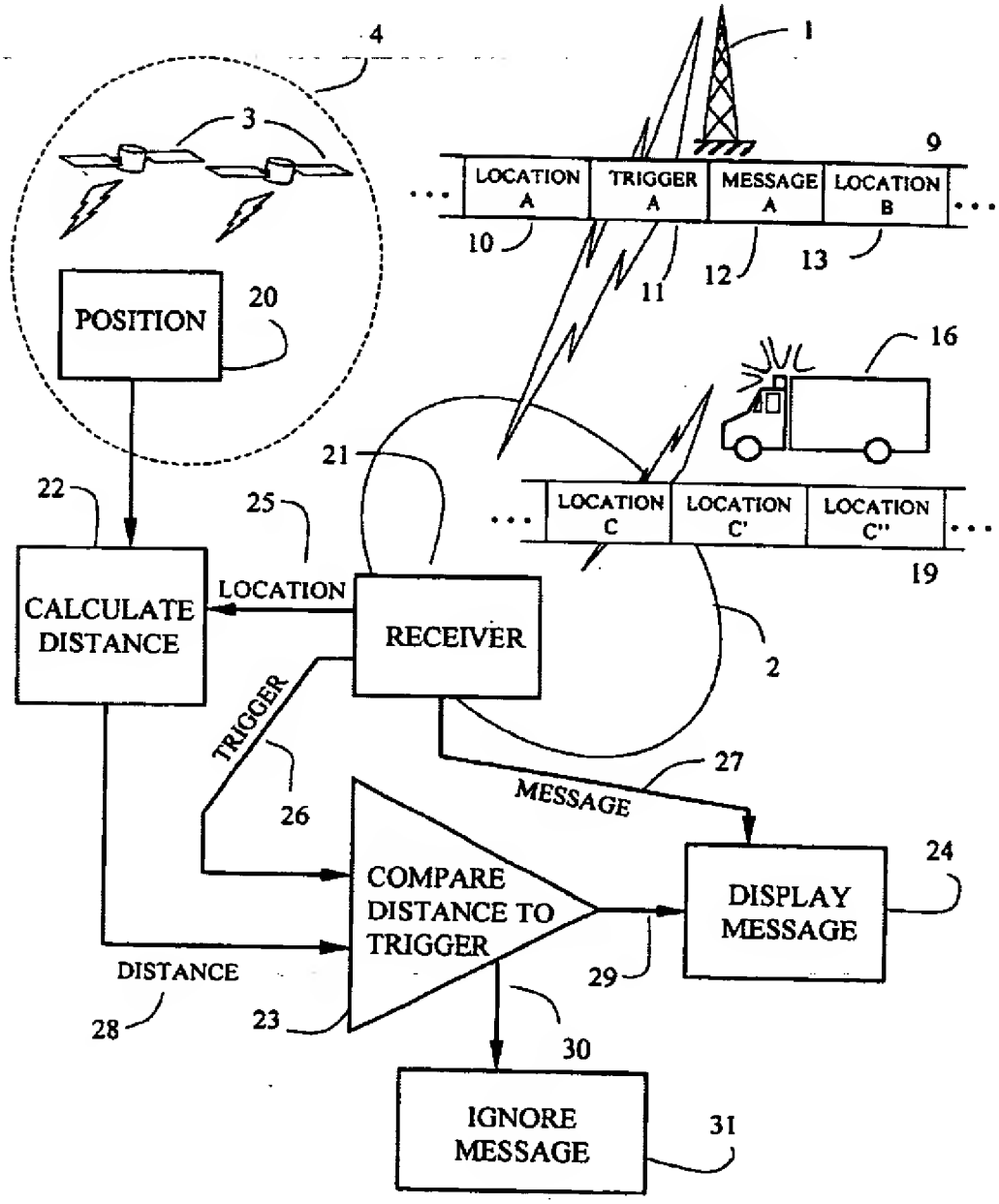

4
3
1
9
LOCATION A
TRIGGER A
MESSAGE A
LOCATION B
10
11
12
13
POSITION
20
16
21
22
25
LOCATION C
LOCATION C'
LOCATION C''
19
CALCULATE DISTANCE
LOCATION
RECEIVER
2
TRIGGER
26
27
MESSAGE
24
COMPARE DISTANCE TO TRIGGER
DISPLAY MESSAGE
DISTANCE
28
23
29
30
IGNORE MESSAGE
31

FIG. 3

POSITION DEPENDENT MESSAGING SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 60/098,389, filed Aug. 29, 1998.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not Applicable

BACKGROUND

1. Field of Invention

This invention relates to an information distribution system which delivers information to recipients only when the recipient is in a particular location

2. Description of Prior Art

Positional awareness due to the advent of GPS and other satellite based location systems is becoming less and less costly. Vehicles and persons using small receivers have knowledge of their geographical position to greater and greater accuracy. Using this knowledge, and delivering information (messages) relevant to location is the purpose of this invention.

In many instances, the usefulness of information is location dependent. This is manifested in the "sales" sign in the window of a store, or the siren of the tire engine. The information delivered may be text, audio, or graphical in nature, or any combination thereof. The key element is the need for the information only in certain geographical locations.

Other inventions propose to deliver messages to distinct places (Buss et al, U.S. Pat. No. 5,539,395). They rely however, on the sub-division of the area of coverage into a predefined grid of smaller areas. The message delivery is effected only within the pre-defined grid element. In order to deliver messages to a larger area, many grid locations must be transmitted, significantly encumbering the transmitter. It is the purpose of this invention to allow a variable area of coverage for each message receiving location, with a greatly reduced amount of transmitted information.

Still other inventions have proposed to avoid collisions amongst a collection of vehicles by having each broadcast its location, and simultaneously receive all others (U.S. Pat. No. 4,835,537 Manion, U.S. Pat. No. 5,068,654 Husher, U.S. Pat. No. 5,153,863 Fraughton, U.S. Pat. No. 5,210,534 Janex, U.S. Pat. No. 5,506,587 Lans). Some of these systems encode messages with the position information that they broadcast (U.S. Pat. No. 5,574,469 Hsu, U.S. Pat. No. 5,450,329 Tanner). Such systems become increasingly complex and cumbersome as the number of vehicles increase. The number of frequencies allocated to these systems must be large, or complex timing algorithms must be employed to avoid having two vehicles transmitting at one time on the same frequency. These types of systems are therefore limited to just a small number of participants. It is the purpose of this invention to allow an unlimited number of participants.

The problem of transmitting information (messages) over a local area has been approached through the use of low power transmissions, which make use of the fact that the signal strength diminishes with distance to achieve a local transmission of information. Lack of signal, or some signal strength threshold becomes the criteria for whether or not

the receiver gets the message. The main and significant difference of this invention over the use of low power transmissions are:

1) Low power transmissions require a transmitter at each location. This invention can cover multiple geographic areas with a single transmitter. Additionally, this invention allows the transmitter to be located far from the location, especially useful if local electrical power is unavailable, the location is hazardous, or if the emission of signals from the location is undesirable.

2) Low power transmissions have a very vague boundary, which may vary due to many effects, such as atmospheric conditions, obstacles, or the orientation of the receiving antennae. This invention does not have any of these limitations, its boundary is constant and its precision is dependent only on the accuracy of the knowledge of one's location.

BRIEF SUMMARY OF THE INVENTION

A position dependent messaging system is disclosed, whereby information (messages) are received only if the message is pertinent to the geographic location of the recipient. Some uses of this invention are as follows:

Emergency vehicle collision avoidance. Cars are being built with greater and greater levels of sound insulation. As such it is increasingly difficult for sirens to be heard, increasing the burden on drivers, who must rely on spotting emergency vehicles more than ever. Accidents involving emergency vehicles themselves or between other vehicles which suddenly react to the presence of the emergency vehicle are common.

Automobile drivers using this invention will receive a warning when an ambulance, fire truck, or police car in an emergency situation approaches within a pre-determined distance. A direction and distance to the emergency vehicle within this distance may be displayed, given in audio format to the driver, or the information may be used to influence autonomous operation, turn off internal devices which may distract the driver, and the like.

Construtuion Work Warning System

Workers on public roads are at risk from motorists, and motorists are confronted with unusual road conditions in construction zones. Typically, temporary signs are used to warn motorists of roadwork or construction. These signs are necessarily simplistic, and are commonly placed too close to the affected area for drivers to take corrective action.

Vehicles employing this invention would receive an additional warning from within their own vehicle, they can be provided with considerable detail on the nature and scope of the changes before they are encountered, and can be advised of alternate routes to avoid the area.

Traffic Alert/Dangerous Condition Warning

Driving hazards vary from the mundane traffic backup to unique events, such as accidents, hazardous material spills, obscuring effects such as smoke or dust across the road, and any number of other hazards. Currently, the main warning system motorists have is via radio reports, which are given from time to time. Information is also typically given for a wide region, and drivers must filter out the information that is relevant to them. Use of this invention would allow minute to minute update of road conditions, automatically filtered for each user of the invention. Furthermore, this service would be continuous, and would only be given to those drivers who are approaching an area of concern. Motorists will receive these alerts miles before the backup, allowing alternate routes to be taken.

High Speed Chase Alert/Road Closure System

High speed chases often result in accidents involving vehicles other than the pursuer and the pursued. Motorcades or the movement of large equipment often require police escort to close a section of road ahead of the primary vehicle. Road closure in these cases is a dynamic event, with the closed section of road actually moving.

Users of the invention will be notified to exit or modify their speed long before the need to do so becomes apparent, reducing risk to the users and reducing the workload of law enforcement officers.

Hazard Navigation

Moving though a mined or otherwise hazardous area is dependent on the knowledge of the safe corridors, which can vary from hour to hour.

Use of the invention would provide the directions for navigation through a mined or hazardous area through the use of known waypoints or specific directions, which will only be given at specific locations to authorized individuals located within the area. Encryption of this information, the dissemination of false information, and providing the information at only specific times are obvious variations which can be employed to ensure that passage by only authorized individuals is possible.

Regional Information Bulletin

Specific areas of danger can be posted without the use of signs, and they can be changed over a wide area from moment to moment. Such information can be updated and distributed much more quickly than a map, and can indicate areas of military concern (regions of sniper activity, contaminated areas, locations about to be attacked, or the location of friendly forces) or general hazards such as the potability of a water source, the location or expected path of a tornado, or other time- or location-dependent information.

Guided Tour

Individuals touring National Parks, Fairs, Museums, or other large public displays typically gather information on their surroundings by written material, either at the site, or in booklets. At temporary sites, sites at which the posting and maintenance of signs is prohibitive, or during short duration events the information is most often given verbally by employees, which may be overly expensive or impossible in some cases.

Use of the invention would allow a large area to be 'documented' and updated quickly at any location. It would allow special events to have the same level of attention as established sights. For example, in a National Park, the blooming of a particular plant, the presence of a particular species, or other events which may occur for only a few days or for only a few hours a day can be 'posted' just as well as geographic features, which themselves may only need a seasonal update.

Orienteering Aid

Orienteering involves the use of map and compass and the following of an unmarked cross country route in a race. Participants begin one at a time, and must reach a series of waypoints marked on a map. The passage of each contestant must be documented at each waypoint. The participant who completes the course in the least amount of time is declared the winner.

With the disclosed invention, no prior physical set up of the course waypoints, documentation of waypoint arrival, or map preparation need be made. Each successive waypoint is presented to the participant at the prior waypoint via a hand held display. In this way the actual extent of the course will not be known to the participants until it is completed, adding a new dimension to the event.

Advertising

Advertising the availability of goods or services is perhaps most effective near the location of the product.

Use of the invention will allow passers by to receive messages advertising specials, or simply to make potential customers aware of the proximity of the product. Such advertising capability can be combined with any of the other aspects of the system disclosed above to allow it to subsidize the service. In such cases, an order of precedence will be beneficial. Advertising would be subordinate to safety messages, for example, and would not be displayed if a safety message is relevant to the user in the same or overlapping location.

The above list is illustrative of the types of service the invention can provide, and is by no means complete. Different types of service using the same or similar patterns are considered obvious variants. Most importantly, users of the invention will enjoy the services offered with complete anonymity. The signals used to overlay the message and position information over a given region are the only transmissions needed. The unlimited number of users within this region need only employ a receiver, in very much the same way as a radio station functions. Information is customized for each user based on the users' position, and other criteria that the user may select. No transmission is needed from the users (receivers) to receive the full benefit of the service.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

FIG. 1 shows a region served with a fixed transmitter and position determining system, showing several and variable sized message delivery areas within the region being served.

FIG. 2 shows a region served by a mobile transmitter and a position determining system, with the mobile transmitter location as the center of a message delivery area.

FIG. 3 shows a block diagram of the device in accordance with the preferred embodiment.

DETAILED DESCRIPTION OF THE INVENTION

This invention intends to provide a system for information (message) delivery to an unlimited number of receivers, for information that varies with time or location. It is furthermore the intention that this information be provided only to those locations where it is relevant. In the context of this disclosure, a 'message' shall consist of any type of information which the recipient may need, presented in any format which is convenient, and may be in audio, visual or other form. Furthermore, a "transmitter" as used in this patent, indicates a radio frequency or other convenient frequency band transmission that covers a broad region. Such a transmitter may be an actual fixed tower, a satellite, a moving vehicle mounted transmitter, or even a loitering aircraft. The key element is that the transmitter need not know or reveal its own location, it merely delivers information relevant to other locations.

In the preferred embodiment, the invention has 4 main modes of deployment, which may operate concurrently with each other:

1) Fixed transmitter, moving receivers
2) Moving transmitter, moving receivers
3) Moving transmitter, fixed receivers
4) Fixed transmitter, fixed receivers

FIG. 1 illustrates the fixed transmitter embodiments, with either moving or stationary receivers. FIG. 1 shows a region

of service 2, served by a fixed transmitter 1. An overlapping region 4 is served by a positional location determining means 3. The area covered by both region 2 and region 4 is the area served by the invention 5. The elements in the broadcast 9 are as follows: a location 10, a trigger distance 11, and a message 12. These elements are broadcast serially, one set for each message. The second message 15, is preceded by it's corresponding location of delivery 13, and it's trigger distance 14 The trigger distance defines the circular area α about the location 'A' within which the message will be displayed. Receivers 6, 7 & 8 will all receive the messages, but if they do not lie within the trigger distance of any of the message locations, the messages are not displayed. Thusly, receiver 6 will display no messages, receiver 7 will display the message 'A', and receiver 8 will display the message 'A' as well as the message 'B'.

FIG. 2 illustrates the moving transmitter embodiments, with either moving or stationary receivers in an area of service 5. A moving transmitter 16 broadcasts a signal 19 to a region of coverage 2. An overlapping region 4 is served by a positional location determining means 3. The area covered by both region 2 and region 4 is the area served by the invention 5. In the preferred embodiment, moving transmitter 16 is an emergency vehicle with sirens on, which will not be obeying traffic rules due to an emergency situation. The elements in the broadcast 19 are, in the simplest embodiment, a repetition of the location of the transmitter 16; 19.1, 19.2, 19.3, 19.4 & 19.5. The location given by 19.1 will be the same as that given by 19.2 if the transmitter 16 is stationary or moving slowly. The location given by 19.3 will be different from that given by 19.4 or 19.5 if the transmitter has moved between the time of the two broadcasts. Additional elements may be added to transmission 19, such as an indication of what type of vehicle, or the nature of the emergency. Such information may be broadcast from time to time, or after each location. In this preferred embodiment, the trigger distance and information is predetermined. Being within the pre-defined trigger distance would cause users of the invention to be warned of the approach of an emergency vehicle. Display of a distance and direction to the emergency vehicle is the preferred message, although a simple light or sound could be used.

FIG. 3 illustrates the functioning of the device. One or more moving transmitters 16 each broadcasts a signal 19 and or one or more fixed transmitters 1 each broadcasts a signal 9, received by receiver module 21. The device is within region 4, which is served by a positional location determining means 3: A module 20 determines the position of the device from the, location determining means 3, and passes this information to module 22. The receiver module 21 breaks up the signal 9 into it's component parts, location 10, trigger distance 11, and message 12. Location 10 is passed onto module 22, where the difference in the location 10 and the position of the device is calculated. The result or this calculation is the distance 28 to the location 10. Receiver module 21 furnishes the trigger distance 26 for comparison to distance 28 in comparator module 23. If distance 28 is less than or equal to trigger distance 26, then the corresponding message 27 is allowed to be displayed by display module 24. If distance 28 is greater than the trigger distance 26, the message 27 is inhibited from being displayed, and is therefore ignored.

In the preferred embodiment, these modules are not distinct hardware elements, but are integrated functions of a single processor based device, modules 22 and 23 are simply calculations performed by the processor.

In the preferred embodiment, a global positioning type system is in place and is providing positional information, however, any means of knowing one's position may be used. The accuracy required for the positional information will depend on the application. For example, minefield navigation may require that one's position be known to meters, whereas the emergency vehicle warning system would only require positional knowledge within tens or hundreds of meters, as long as message display in this embodiment begins at even greater distances (a kilometer, for example).

In the preferred embodiment, several modes as described above may operate simultaneously, such as the Emergency Vehicle Warning System and the Traffic Alert system. The Emergency Vehicle Collision Avoidance System would employ mobile transmitters on each ambulance. Each ambulance would know its own position, and broadcast that location when the siren was turned on. The ambulance location being broadcast would be updated continuously as the vehicle moves. Cars (receivers) would receive the signal miles away, but only those within, say, a kilometer would be notified by the invention. The distance and direction to the ambulance can then be displayed to the driver (display of the direction to the ambulance would require that the receiving vehicle also knew which way it was pointing).

The Traffic Alert system would employ a centrally located fixed transmitter, and vehicles (receivers) moving within its range would be receiving road condition information for the entire area. Vehicles which enter a defined message area (within the trigger distance of a specific location) will display the message. The message area can be a single location or a multitude of locations each with its own trigger distance, spaced so as to define any geometric area needed for message delivery.

The fixed receiver condition would apply, for example, to both of the above cases whenever any vehicle is stopped. In these cases, the only signals that it would display would be those that changed with time, such as when an emergency vehicle passes close by.

Different components of a combined system may use different frequencies to avoid conflict. For example, a fixed transmitter serving a region for Traffic Alert may be on a different frequency than ambulances, fire trucks, and other mobile transmitters. Because the number of transmitters is low, and the information being transmitted by mobile transmitters is simple, mobile transmitters may employ various schemes for sharing frequency or simply use distinct frequencies.

Frequency sharing schemes may be employed such as by coordinating the timing of transmissions so that they do not overlap. This is facilitated by the use of the positional locating system's signal as a time-coordination device, and staggering broadcasts throughout a pre-defined time interval. For example, ambulance #1 uses the time interval from 0 to 0.01 sec, ambulance #2 uses 0.02 to 0.03, etc. . . . All the vehicles using the system are synchronized because they all use the same satellite based signals to determine their own position.

What I claim is:

1. A message delivery system consisting of transmitters, receivers, and a position location means, said transmitters broadcasting a signal containing messages with corresponding locations at which said messages are to be delivered, said receivers discriminating in the delivery of said messages in the following manner:

a) said receivers determine their own position via said position location means

b) said transmitters broadcast said signal containing said messages along with said corresponding locations

c) said receivers deconstruct said signal, and determine their proximity to each of said locations via a calculation means

d) said receivers deliver said messages if the proximity of said receiver to any of said corresponding locations is less than or equal to a predetermined distance

said message being information in audio, visual, or other convenient form, and said transmitters are not co-located with said receivers.

2. The invention as described in claim 1, wherein a trigger distance is transmitted along with said location and said message, said receiver comparing its position against said location via said calculation means, delivering said message only if said comparison yields a value less than or equal to said trigger distance.

3. The invention as described in claim 1, wherein a device specific address is also broadcast, said receivers compare their address with said device specific address, ignoring said message if said address does not correspond to said device specific address.

4. A message delivery system consisting of transmitters, receivers, and a position location means, said transmitters broadcasting a signal containing messages and the current location of said transmitter, said receivers discriminating in the delivery of said messages in the following manner:

a) said receivers determine their own position via said position location means

b) said transmitters broadcast said signal containing said messages along with said location of said transmitter

c) said receivers deconstruct said signal, and determine their proximity to said location via a calculation means

d) said receivers deliver said messages if the proximity of said receiver to any of said corresponding locations is less than or equal to a predetermined distance

said message being information in audio, visual, or other convenient form, and said transmitters are not co-located with said receivers.

5. The invention as described in claim 4, wherein said message is determined by the receiver based on information derived from the position of said transmitter and said receiver, such as bearing, distance, closure speed and the like.

6. The invention as described in claim 4, wherein said transmitter broadcasts said message, containing information such as the type of emergency vehicle, the emergency vehicle speed, or any other information useful to said receiver.

7. A position dependent message delivery system employing a fixed transmitter with a defined area of coverage, said transmitter producing a signal with the following content:

a) geographical location

b) discrimination criteria, such as threshold distance, heading, speed, message content identifier, or the like

c) a message corresponding to said location and said discrimination criteria

said signal continuously repeated with one or more distinct locations, associated discrimination criteria, and messages, in sequence, said message delivery system also including one or more receivers, free to move about said area of coverage anonymously, said receivers determine their position via a position location means, said receivers compare said geographical location in said signal with said position, calculate the distance between said geographical location and said position via a calculation means, and only deliver said message if said distance is less than said threshold distance.

8. The invention as described in claim 7, wherein said discrimination criteria are additionally compared with information determined by or furnished to said receivers, to further restrict the number of said messages delivered.

9. A position dependent message delivery system employing a mobile transmitter and a first position location means, said transmitter producing a signal with the following content:

a) the current location of said transmitter, as determined by said first position location means

said signal continuously repeated, said message delivery system also including one or more receivers, free to move about anooymously, said receivers determine their position via a second position location means, said receivers compare said current location in said signal with said position, and only deliver a pre-determined message if said current location is sufficiently close to said position.

10. The invention as described in claim 9, wherein said signal also includes the following elements:

b) a message

said receivers compare said current location in said signal with said position, and only deliver said message if said current location is sufficiently close to said position.

11. The invention as described in claim 10, wherein said signal also includes the following elements:

c) a threshold distance

said receivers determine the distance from said current location to said position via a calculation means, and only deliver said message if said distance is less than said threshold distance.

12. The invention as described in claim 11, wherein said signal also includes the following elements:

d) discrimination criteria, such as heading, speed, message content identifier, or the like

said receivers additionally compare said discrimination criteria to other known information, and only deliver said message if said discrimination criteria are met.

* * * * *

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